Canada–B.C.
Conservation and Renewable Energy Demonstrations

B.C. 26

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Conservation and Renewable Energy Branch

Energie, Mines et Ressources Canada
Bureau de la conservation et des énergies renouvelable

Province of British Columbia

Ministry of Energy, Mines and Petroleum Resources
CONSERVATION AND TECHNOLOGY DIVISION

SOLAR HOT WATER HEATING AT FIR PARK VILLAGE INTERMEDIATE CARE HOME, PORT ALBERNI, B.C.

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CANADA-BRITISH COLUMBIA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

This report was jointly prepared by Jim Traynor, of David N. Spearing & Associates, Architects, and by the B.C. Ministry of Energy, Mines and Petroleum Resources.

PROJECT SPONSORED BY:

THE ALBERNI VALLEY INTERMEDIATE CARE HOME SOCIETY

Co-sponsors:

Farmer Construction Ltd.	Victoria
Solarsystems Industries Ltd..	Vancouver
David N. Spearing & Associates	Nanaimo
Antrim Mechanical Ltd.	Nanaimo
Sterling Cooper & Associates	Vancouver
Pomeroy Engineering Ltd.	Vancouver
R.A. Freundlich & Associates	Victoria
W.A. Goodbrand & Associates	Vancouver
Willet Osborne Electric	Victoria

CANADA/BRITISH COLUMBIA CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

The availability of secure and affordable energy supplies is a subject of national concern. It is an accepted fact that our primary energy sources - oil and natural gas - are becoming less accessible and more costly. However, Canada is well-endowed with non-renewable and alternative resources that can provide a bridge into the future.

To this end, the government of British Columbia and Canada have entered into a Conservation and Renewable Energy Demonstration Agreement. The Agreement is dedicated to the development and demonstration of conservation and renewable technologies.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies, which, when widely adopted, will exploit renewable resources, conserve energy and/or use energy more efficiently.
- To develop broad public awareness of the potential of renewable energy and conservation technology.
- To provide opportunities for the commercial application of the technologies within B.C.
- To create employment in new or existing energy-related industries.

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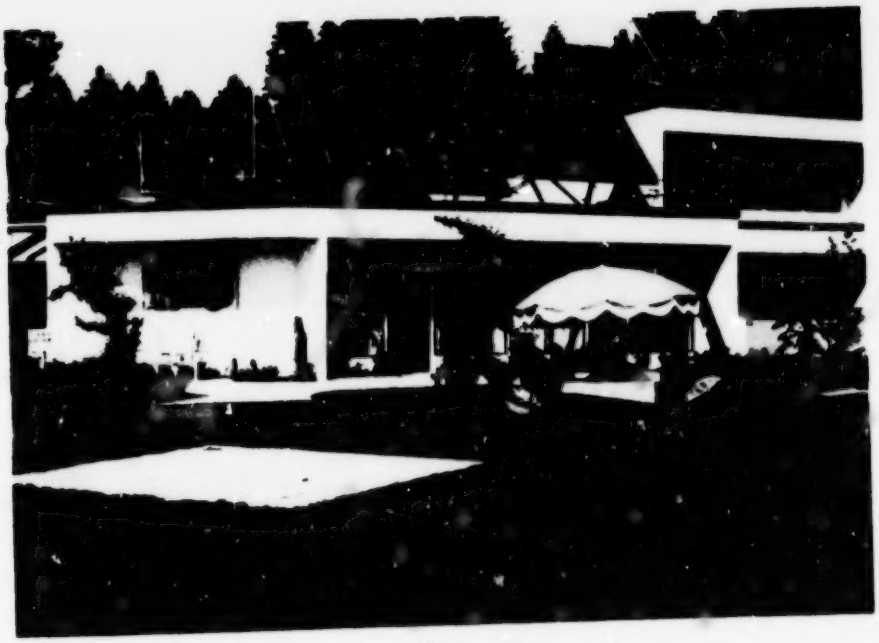


SUMMARY

An active solar water preheating system was installed in mid-1982 at Fir Park Village Intermediate Care Home in Port Alberni, Vancouver Island, B.C. The capital cost of the system was $83,780. The performance of the system was monitored, using Rho Sigma BTU meters, pyranometer, kilowatt-hour meters and thermometers, and the first year's results are presented here.

The system preheats water for domestic usage and the spa pool. It replaces electricity, which is subject to rationing on Vancouver Island. The installation is a Solarsystems Industries drainback type, consisting of 125 square metres (net) of collectors with single low-iron glazing and copper absorber plates with selective surface. The storage capacity of the solar tank is 9,600 litres. The design, manufacture and installation of the system was all done by southwestern British Columbia manpower.

In the first year of operation the system supplied 22.1% of the home's kitchen, spa pool and south wing hot water needs. The contribution of 61.7 gigajoules resulted in a net saving of 16,925 kilowatt-hours of electricity, worth $780.

The system did not operate properly in the spring and summer of 1983 and was finally shut down in September 1983 for repairs. The system was put back into operation, by the supplier, in January 1984, after a long servicing and problem solving delay followed by minor system modifications.

INTRODUCTION

The east coast of Vancouver Island experiences population growth partly because of a climate which has less precipitation and more insolation than other areas of the British Columbia coast. The demonstration, locally, of active solar water heating for residential/institutional use together with performance monitoring can accelerate acceptance of this renewable energy technology. This would help ease the demand for hydroelectric power and fossil fuels and could be particularly important for Vancouver Island which is short of traditional energy resources. The costs of delivering hydro and fossil fuels to the Island are environmental and social as well as economic.

The demonstration that solar energy can be effectively captured in Port Alberni was an objective of the Fir Park Village Solar Project. Port Alberni lies outside of the mountain rainshadow and has significantly less insolation than Nanaimo and Victoria on the east coast of Vancouver Island. Fir Park Village has a high demand for hot water because it provides complete domestic service including kitchen, laundry, bathing, hairstyling, and whirlpool spa for 67 full-time residents, an additional 15 daycare residents, plus hot meals for seniors in the community by meals on wheels, and meals available to seniors in 80 adjacent cottages and apartments.

The project was proposed and managed by David N. Spearing and Associates, Architects, Nanaimo, B.C. The project was jointly funded by the Canada/British Columbia Conservation and Renewable Energy Demonstration Agreement (CREDA) and the co-sponsors listed on page (i) of this report. The solar heating system was supplied by Solarsystems Industries, Richmond, B.C. and installed under their supervision, as prime contractors, with completion in August 1982. Plumbing and on-site fabrication was done by Antrim Mechanical Ltd., Nanaimo, under subcontract to Solarsystems Industries Ltd. Performance monitoring has proceeded since September 1982. The total cost of the project, including feasibility study, monitoring and information transfer, was $91,000.

The Fir Park Village active solar hot water system was designed to supply 50% of the home's kitchen, whirlpool spa and south wing hot water needs. The solar system replaces electricity which is subject to rationing on Vancouver Island.

The stimulation of manufacturing and supply industries and local installation industries was an objective of the Fir Park Village Project. This project also serves as a demonstration for the students of Malaspina College Energy Systems Technology Program in Nanaimo, and through monitoring, provides cost/benefit information to the public.

SYSTEM DESCRIPTION

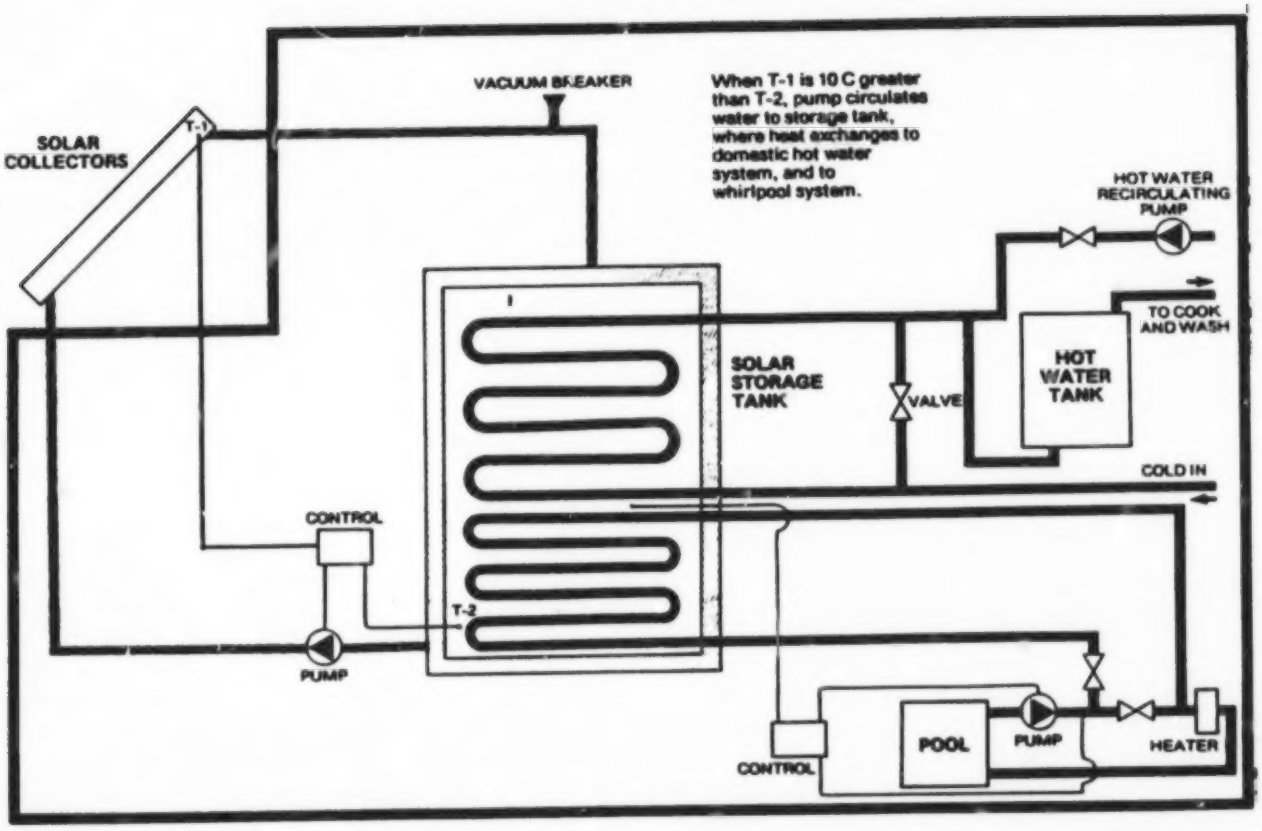
The system flow chart and manufacturer's detailed specifications are in Appendices 1 and 2 respectively. Figure 1 is a simplified schematic of the system operation. Following is a description of the system.

Sixty-two glazed solar collectors (Solarsystems SOL 100) are mounted on two roof areas facing south at a tilt of 45°. Solar storage is provided by a 9600 L unpressurized water tank located on the ground floor. Circulation in the solar loop is achieved by a 3/4 hp pump. Automatic control of the solar loop is governed by a differential thermostat (DT-14H). Heat transfer from the solar tank to the domestic hot water system and spa is achieved by drawing water through heat exchange coils installed in the solar storage tank.

The differential thermostat compares the temperatures (as measured by remote sensors located in drywells) at one collector array and the bottom of the storage tank. Whenever the collectors are 10°C warmer than the storage tank the thermostat activates the solar pump through a magnetic relay. Water is drawn from the bottom of the solar tank and fed to each of the collector arrays before being returned to the top of the tank. Circulation continues until the tank temperature rises to within 1°C of the collectors at which time the pump stops. Air is then admitted to the solar loop through the vent system and the water drains back to storage. Freeze protection is achieved by the drainback principle. Overtemperature protection is provided by a high limit on the DT-14H thermostat. This prevents the system from operating once the solar tank has reached 85°C. A light on the thermostat indicates this mode.

Float valves installed on each collector array assist in purging air from the system during start-up and admit air during system drainback. Balancing valves at the inlet of each array are set to the fully open position. They may be closed to isolate an array for servicing. Shut off valves are located at the outlet of each array to permit isolation for servicing and to regulate flow. These valves are preset and tagged. Pressure relief valves on each array ensure that no damage will result from an array being isolated during hot weather. Hose bibs are installed at the inlet of each array to permit draining for servicing purposes.

Figure 1


SOLAR COLLECTORS
T-1
VACUUM BREAKER
When T-1 is 10 C greater than T-2, pump circulates water to storage tank, where heat exchanges to domestic hot water system, and to whirlpool system.
HOT WATER RECIRCULATING PUMP
TO COOK AND WASH
SOLAR STORAGE TANK
VALVE
HOT WATER TANK
COLD IN
CONTROL
T-2
PUMP
CONTROL
POOL
PUMP
HEATER

Domestic Hot Water

Whenever a hot water service is in use, cold city water is drawn through the 180' x 1" heat exchange coil in the solar storage tank. This preheated water then passes to the DHW tank #3.

Whirlpool

The whirlpool heat exchange loop is controlled by differential thermostat DT-32H. Flow is provided by the existing whirlpool pump. The DT-32H compares the storage tank temperature with the whirlpool temperature. Whenever the tank is 5°C warmer than the whirlpool, solar-heated water will flow through the 60' x 1 1/2" heat exchange coil in the tank. This heat collection will continue until either the whirlpool temperature reaches within 1°C of the storage tank temperature or the whirlpool reaches its setpoint temperature.

Monitoring

The monitoring consists of a Rho Sigma pyranometer for measuring the amount of solar energy available; a Rho Sigma BTU meter to measure flow and solar BTUs delivered to the domestic hot water (DHW) tank; a Rho Sigma BTU meter to measure flow and solar BTUS delivered to the pool (spa); a solar pump timer; and thermometers on the collector loop and on the heat exchanger lines into and out of the solar tank. In addition, two kWh meters are installed for measuring the backup electrical energy for the DHW and for the pool, separately.

System Maintenance

The system is virtually maintenance-free except for cleaning, observing controls, topping up water at storage tank sight glass (monthly check), and topping storage tank oil (annual check).

PERFORMANCE OF THE SYSTEM

Substantial completion of the construction contract was awarded on August 13, 1982. Readings of the kWh meter at the domestic hot water tank commenced on March 11, 1982. Readings of the other meters have been recorded regularly since September 16, 1982.

The whirlpool spa was not operational until the end of 1982 because of delays in issuance of a pool operating certificate. The whirlpool has not yet been hooked up to the solar system because of concerns about the effect of the whirlpool system chemicals.

Based on the f-CHART computer simulation program, it was estimated that with 148 m^2 of collector area the solar system would supply 52.6% of the hot water demand of the kitchen, whirlpool spa and south wing of the building. The computer printout is shown in Figure 2. The final design used 136m^2 (gross) of collector area, and the system was estimated to supply about 50% of the hot water demand.

The energy demand by the applicable end uses was estimated to be 990,000 KJ/day, as determined by the consulting engineers. Thus, the solar system was expected to supply 180 GJ/year, or 50,190 kWh/year.

The monitoring data and performance results for the one-year period from September 1982 to September 1983 are shown in Table 1 and Figures 3 and 4. The Table and Figures show clearly that the system developed serious operating problems in the spring of 1983.

Of the 539.9 GJ of solar radiation received by the 125 m^2 (net) of collector surface, 61.7 GJ were delivered to the building's domestic hot water by the solar installation. 11.4% of the available solar energy was delivered by the installation.

The solar installation supplied 22.1% of the applicable hot water energy requirements of the building over the one-year period. The solar contribution totalled 61.7 GJ, or 17,150 kWh. The solar pump consumed 0.9 GJ (225 kWh) of electricity; thus the net solar contribution for the year was 16,925 kWh, worth approximately $780 at 1982/83 electricity rates.

Figure 2

PORT ALBERNI

SOLAR FRACTION - EXHIBIT 1

CODE	VARIABLE DESCRIPTION	VALUE	UNITS
1	AIR SH+WH=1, LIQ SH+WH=2, AIR OR LIQ WH ONLY=3.	3.00	
2	IF 1, WHAT IS (FLOW RATE/COL. AREA)(SPEC. HEAT)?	0.00	W/C-M2
3	IF 2, WHAT IS (EPSILON)(CMIN)/(UA)?.....	0.00	
4	COLLECTOR AREA.....	148.00	M2
5	FRPRIME-TAU-ALPHA PRODUCT(NORMAL INCIDENCE)..	.75	
6	FRPRIME-UL PRODUCT.....	5.00	W/C-M2
7	INCIDENCE ANGLE MODIFIER (ZERO IF NOT AVAIL.)	0.00	
8	NUMBER OF TRANSPARENT COVERS.....	1.00	
9	COLLECTOR SLOPE.....	45.00	DEGREES
10	AZIMUTH ANGLE (E.G. SOUTH=0, WEST=90).....	0.00	DEGREES
11	STORAGE CAPACITY.....	288.70	KJ/C-M2
12	EFFECTIVE BUILDING UA.....	0.00	KJ/C-DAY
13	CONSTANT DAILY BLDG HEAT GENERATION.....	0.00	KJ/DAY
14	HOT WATER USAGE.....	3747.60	L/DAY
15	WATER SET TEMP. (TO VARY BY MONTH, INPUT NEG.;)	71.00	C
16	WATER MAIN TEMP(TO VARY BY MONTH, INPUT NEG.;)	8.00	C
17	CITY CALL NUMBER.....	0.00	
18	THERMAL PRINT OUT BY MONTH=1, BY YEAR=2.....	1.00	
19	ECONOMIC ANALYSIS ? YES=1, NO=2.....	2.00	

USER SUPPLIED DATA 49.25

****THERMAL ANALYSIS****

TIME	PERCENT SOLAR	INCIDENT SOLAR (GJ)	HEATING LOAD (GJ)	WATER LOAD (GJ)	DEGREE DAYS (C-DAY)	AMBIENT TEMP (C)
JAN	0.0	16.76	0.00	30.67	543.	.6
FEB	19.6	27.68	0.00	27.70	436.	2.6
MAR	44.8	46.92	0.00	30.67	412.	4.7
APR	65.3	60.90	0.00	29.68	300.	8.0
MAY	86.7	83.77	0.00	30.67	182.	12.1
JUN	85.0	77.60	0.00	29.68	106.	14.7
JUL	97.9	94.17	0.00	30.67	44.	17.7
AUG	94.9	89.26	0.00	30.67	41.	17.4
SEP	95.9	89.43	0.00	29.68	110.	14.5
OCT	35.3	37.94	0.00	30.67	257.	9.7
NOV	3.4	19.93	0.00	29.68	396.	4.8
DEC	0.0	13.37	0.00	30.67	484.	2.4
YR	52.6	657.74	0.00	361.08	3311.	

TABLE 1

(1) PERIOD	(2) SOLAR RADIATION AVAILABLE		(3) SOLAR ENERGY DELIVERED	(4) AMOUNT OF AVAILABLE SOLAR ENERGY DELIVERED (b)	(5) AUXILIARY ENERGY USED BY DHW	(6) AUXILIARY ENERGY USED BY SPA	(7) SOLAR CONTRIBUTION (c)	(8) ENERGY USED BY SOLAR PUMP	
	BTUs/sq.ft.	GJ(a)	GJ	%	GJ	GJ	%	Hours of use	kWh(d)
1982									
1/2 Sept.	20,719	29.4	5.8	19.7	5.0	-	53.7	-	-
Oct.	24,492	34.8	8.1	23.3	13.3	-	37.9	-	-
Nov.	13,348	19.0	4.7	24.7	21.1	-	18.2	38	21
Dec.	5,294	7.5	1.3	17.3	22.6	1.7	5.1	8	4
1983									
Jan.	6,510	9.2	1.4	15.2	22.9	1.2	5.5	15	8
Feb.	12,955	18.4	3.4	18.5	18.4	1.0	14.9	36	20
Mar.	29,470	41.8	8.7	20.8	12.1	0.9	40.1	73	41
Apr.	51,890	73.7	13.0	17.6	12.0	0.9	50.2	108	60
May	47,276	67.1	8.3	12.4	29.3	0.7	25.9	57	32
June	37,387	53.1	2.2	4.1				37	21
July	50,378	71.5	3.0	4.2	15.9	0.3	15.6	21	12
Aug.	53,020	75.2	1.3	1.7	15.8	0.3	7.5	8	4
1/2 Sept.	27,639	39.2	0.5	1.3	22.6		2.2	4	2
Full Yr.	380,378	539.9	61.7	11.4	211.0	7.0 (e)	22.1	405	225(f)

(a) To net collector area of 125 m^2.
(b) Column 3 ÷ Column 2, x 100%.
(c) Column 3 ÷ (Column 3 + Column 5 + Column 6), x 100%.
(d) Pump rated at 3/4 hp.
(e) December 1982 to September 1983.
(f) November 1982 to September 1983.

Figure 4
Solar Energy Collection Efficiency

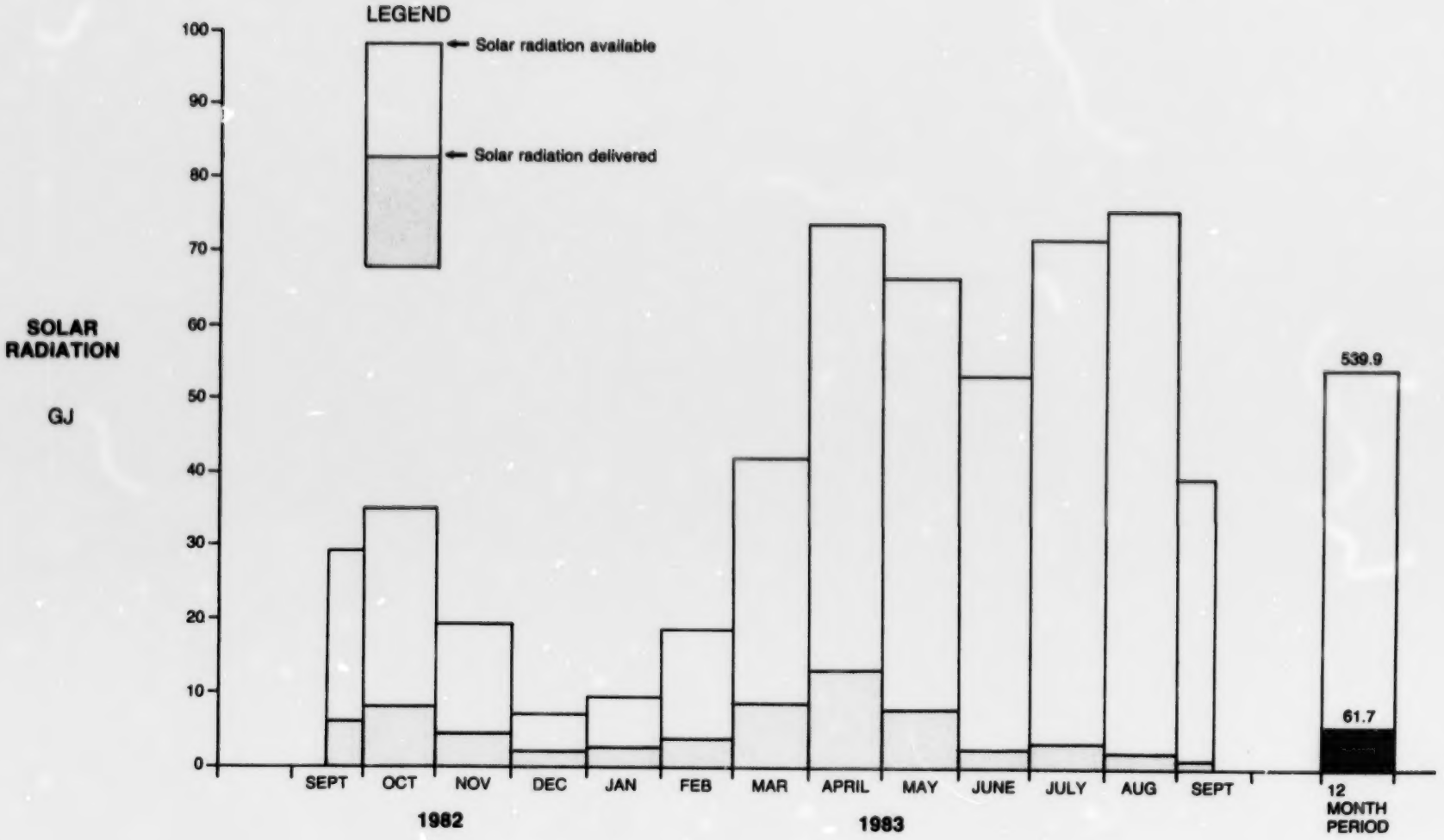
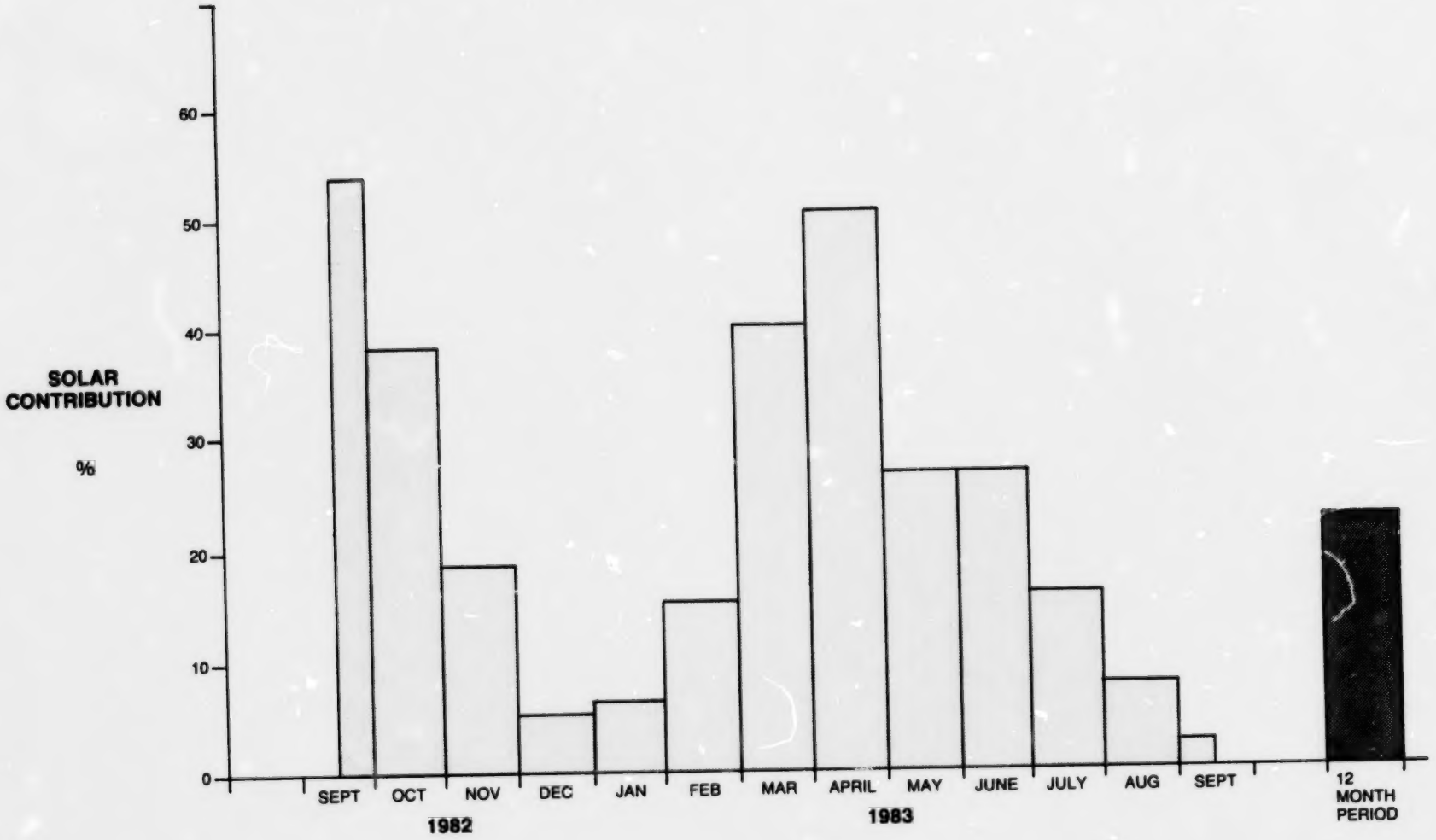


Figure 3
Solar Contribution



These performance figures don't measure the potential capability of the solar installation, because the system didn't operate properly during the final four months of the period. The solar circulating pump was cutting out prematurely. The problem became apparent to the operators in August 1983, and the system was shut down in late September. A servicing delay of four months was experienced before a solution was developed by Solar-Systems Industries Ltd. Testing by the supplier showed that too much water was circulating through the system, causing the pump motor to operate at its maximum current, and cut out on overheat protection. To reduce the water flow to the design value of 45 U.S.G.P.M., a flow restrictor was installed in the collector return line. An overload heater was installed to correspond to a corrected service factor rating supplied by the pump motor manufacturer. The system was then put back into operation in January 1984.

Unfortunately, the period during which the system was defective was the period of highest insolation, May through September 1983. It is difficult to estimate what the system's performance would have been if it had been operating properly, but the annual solar contribution would have been much higher than 22.1%. During the September 1982 through April 1983 period, the solar contribution was 26.7%. However, the 50% contribution originally estimated would not have been attained.

The total energy used to heat the domestic hot water in the applicable sections of the building, during the one year period, was 61.7 GJ + 211.0 GJ = 272.7 GJ (see Table 1). The energy used to power the spa was 7.0 GJ over a nine-month period. Thus, the fact that the solar system was not hooked up to the spa was not a signficant factor in the poor performance.

It has been found on other British Columbia CREDA projects that the Rho Sigma BTU meters read low by up to 40%. If this was the case on this particular project, the actual performance of the solar installation would have been significantly better than was measured.

If an accurate diagnosis had been achieved, when the pump problem first became evident, the out of service time for modifications could have been reduced substantially - probably by three months.

COST REVIEW

The expenditures were as follows:

1. Active solar system equipment supply and installation:

Design and engineering	$ 5,000
Concrete base & steel racking system	18,000
Solar collector panels	30,000
Solar storage tank	8,670
Piping & circulation pump	10,000
Controls	1,180
Insulation & electrical	5,000
Commissioning	1,000
	$78,850

2. Monitoring equipment supply, installation and commissioning: $ 4,820

3. Architectural design and engineering integration with building systems. Administration of proposal call, construction contract, construction accounting certification. Control review of proposals, shop drawings and specifications. On-site construction inspections: $ 4,930

4. Information transfer, printing, photography, graphic layout, report: $ 2,400

CONCLUSIONS

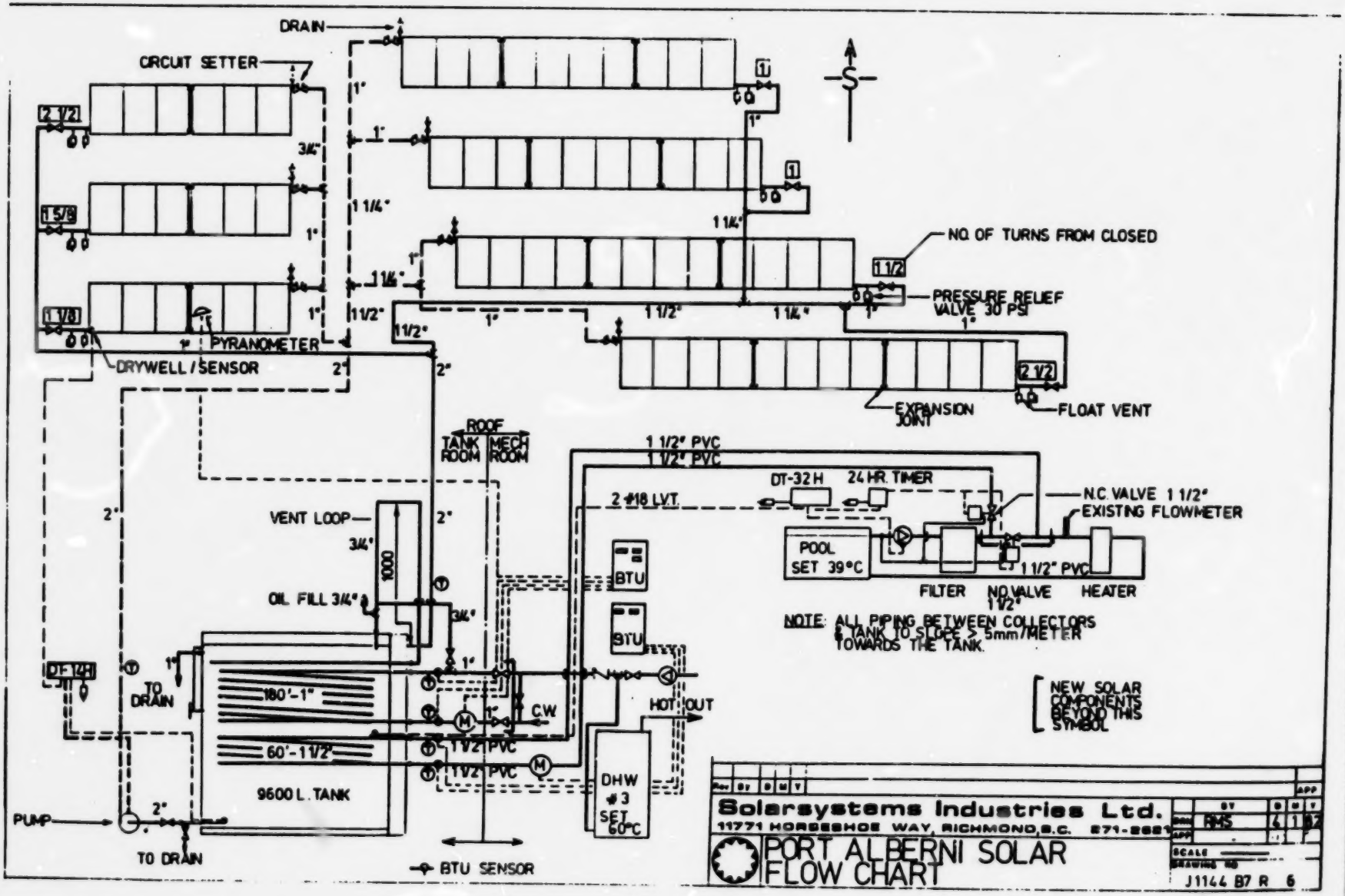
The solar installation supplied 22.1% of the applicable domestic hot water and spa energy needs over the one-year monitoring period, saving 16,925 kWh of electricity. 11.4% of the available solar energy was delivered by the solar installation. The performance would have been considerably better if the system had not encountered operating problems during the May through September period, the period of highest insolation. Also, the actual performance may be as much as 40% better than the measured performance, because of inherent inaccuracy of the BTU meters.

Post construction servicing and problem solving by the supplier was of long duration, resulting in a four month period when the system was totally out of operation.

The system saved $780 in electricity during the first year of operation, compared to its capital cost of $83,780.

APPENDIX ONE

Schematic Flow Chart for Active Solar
Water Preheating at Fir Park Village


DRAIN
CIRCUIT SETTER
2 1/2
1 5/8
1 1/8
PYRANOMETER
DRYWELL / SENSOR
NO. OF TURNS FROM CLOSED
1 1/2
PRESSURE RELIEF VALVE 30 PSI
EXPANSION JOINT
2 1/2
FLOAT VENT
ROOF
TANK ROOM
MECH ROOM
1 1/2" PVC
1 1/2" PVC
DT-32H
24 HR. TIMER
2 #18 LVT
N.C. VALVE 1 1/2"
EXISTING FLOWMETER
VENT LOOP
1000
POOL SET 39°C
BTU
BTU
1 1/2" PVC
FILTER
NO VALVE 1 1/2"
HEATER
OIL FILL 3/4"
NOTE: ALL PIPING BETWEEN COLLECTORS & TANK TO SLOPE > 5mm/METER TOWARDS THE TANK.
DT-14H
TO DRAIN
180'-1"
60'-1 1/2"
C.W.
HOT OUT
1 1/2 PVC
1 1/2 PVC
9600 L. TANK
DHW #3 SET 60°C
PUMP
TO DRAIN
BTU SENSOR
NEW SOLAR COMPONENTS BEYOND THIS SYMBOL
Solarsystems Industries Ltd.
11771 HORSESHOE WAY, RICHMOND, B.C. 271-2621
PORT ALBERNI SOLAR FLOW CHART
SCALE
DRAWING NO
J1144 B7 R 6

APPENDIX TWO

Solar Heating System Specifications

PORT ALBERNI CARE HOME SOLAR

DOMESTIC HOT WATER AND SPA SYSTEM

OPERATING AND MAINTENANCE INSTRUCTIONS

Contents

A) The System

B) Solar Loop Operation

C) Miscellaneous Controls

D) Utilization of Collected Heat

E) Monitoring Equipment

F) System Maintenance

G) Diagrams and Specifications

- i) Flow Chart - Drawing No. J1144-B7
- ii) Solarsystems SOL 100 Collector Specifications
- iii) Solarsystems SOL 750 Solar Storage Tank Specifications
- iv) Solarsystems DTF - Series Differential Thermostat Specifications
- v) Monarch ACE-75 Pump Specification
- vi) Richdel R219/R221 Solenoid Valve Specification
- vii) Sensor Resistance Temperature Chart (applicable to control and monitoring sensors)

Solarsystems Industries Ltd.,
2-11771 Horseshoe Way,
Richmond,
B.C. V7A 4S5

Tel: 271-2621

SOLARSYSTEMS

PORT ALBERNI CARE HOME

SOLAR DOMESTIC HOT WATER AND SPA SYSTEM

OPERATING AND MAINTENANCE INSTRUCTIONS

A) The System

The system is designed primarily to preheat cold city water prior to it entering domestic hot water tank #3; this unit provides hot water for the cafeteria. A secondary function is to provide heat to a whirlpool.

Sixty-two glazed solar collectors (Solarsystems SOL 100) are mounted on two roof areas facing south at a tilt of 45^{o}.

Solar storage is provided by a 9600 L unpressurized water tank located on the ground floor.

Circulation in the solar loop is achieved by a 3/4 hp pump.

Automatic control of the solar loop is governed by a differential thermostat (DT-14H). This unit should be set to the "AUTO" position.

Heat transfer from the solar tank to the domestic hot water system and spa is achieved by drawing water through heat exchange coils installed in the solar storage tank.

B) Solar Loop Operation

Differential thermostat DT-14H compares temperature readings (as measured by remote sensors located in drywells) at one collector array and the bottom of the storage tank. Whenever the collectors are $10^{o}C$ warmer than the storage tank the DT-14H activates the solar pump through a magnetic relay. Water is drawn from the solar tank and fed to each of the collector arrays before being returned to the top of the tank. Circulation will continue until the tank temperature rises to within 1^{o} C of the collectors at which time the pump will stop. Air is then admitted to the solar loop through the vent loop above the tank and the whole system drains back to storage. Heat collection is therefore completely automatic. Freeze protection is assured by the drainback principle.

Overtemperature protection is provided by a high limit on the DT-14H thermostat. This feature will prevent the system from operating once the solar tank has reached 85°C. A light on the thermostat will indicate this mode.

C) Miscellaneous Controls

1) Float valves installed on each collector array assist in purging air from the system during startup and admit air during system drain-back. The system will still drain satisfactorily should any or all of these vents malfunction.

2) Balancing valves at the inlet of each array are set to the fully open position. They may be closed to isolate an array for servicing.

3) Shut off valves are located at the outlet of each array to permit isolation for servicing and to regulate flow. These valves are pre-set and tagged. See Drawing J1144-B7 for settings.

4) Pressure relief valves on each array ensure that no damage will result from an array being isolated during hot weather.

5) Hose bibs are installed at the inlet of each array to permit draining for servicing purposes.

D) Utilization of Collected Heat

1) Domestic Hot Water

Whenever a hot water service is in use cold city water is drawn through the 180' x 1" heat exchange coil in the tank, this preheated water then passing to the DHW tank #3.

2) Whirlpool

The whirlpool heat exchange loop is controlled by differential thermostat DT-32H. Flow is provided by the existing whirlpool pump. The DT-32H compares the storage tank temperature with the whirlpool temperature. Whenever the tank is 5°C warmer than the whirlpool the normally-open and normally-closed valves will be operated thus diverting flow through the 60' x 1½" heat exchange coil in the tank.

This heat collection will continue until either the whirlpool temperature reaches to within 1°C of the storage tank or the whirlpool reaches the setpoint established on the DT-32H. (This feature is user-adjustable). This unit should be set to the "AUTO" position.

E) Monitoring Equipment

1) Thermometers are installed across each of the heat exchange coils and on the supply and return lines to the solar arrays.

2) BTU meter sensors are installed across the DHW and whirlpool heat exchangers. Readouts on each of the BTU meters give a measure of energy extracted from the solar tank. Readings are in BTU's.

3) A flow meter is installed on the "cold" inlet of each heat exchanger. Readouts are located on the top of each flow meter and on each BTU meter. Readings are in U.S. gallons.

4) A pyranometer is installed on one of the collector arrays in the same plane and orientation as the solar collectors.

This unit provides a measurement of solar radiation falling on the solar array. A readout on the DHW BTU meter gives a reading in BTU/ft^2.

5) A thermometer is installed in the storage tank.

F) System Maintenance

With very few mechanical components the system is virtually maintenance free. Normal operating patterns will quickly become apparent; any irregularities should be reported to the manufacturer.

Solar Collectors: Wash with water and mild detergent if dirt buildup is excessive.

Storage Tank: Check sight glass once a month. Top up water as necessary. Add a liter of motor oil through the oil fill once a year.

Controls: No maintenance. A table indicating resistance readings/ temperatures for all sensors used in the system is included in this manual for future trouble-shooting purposes.

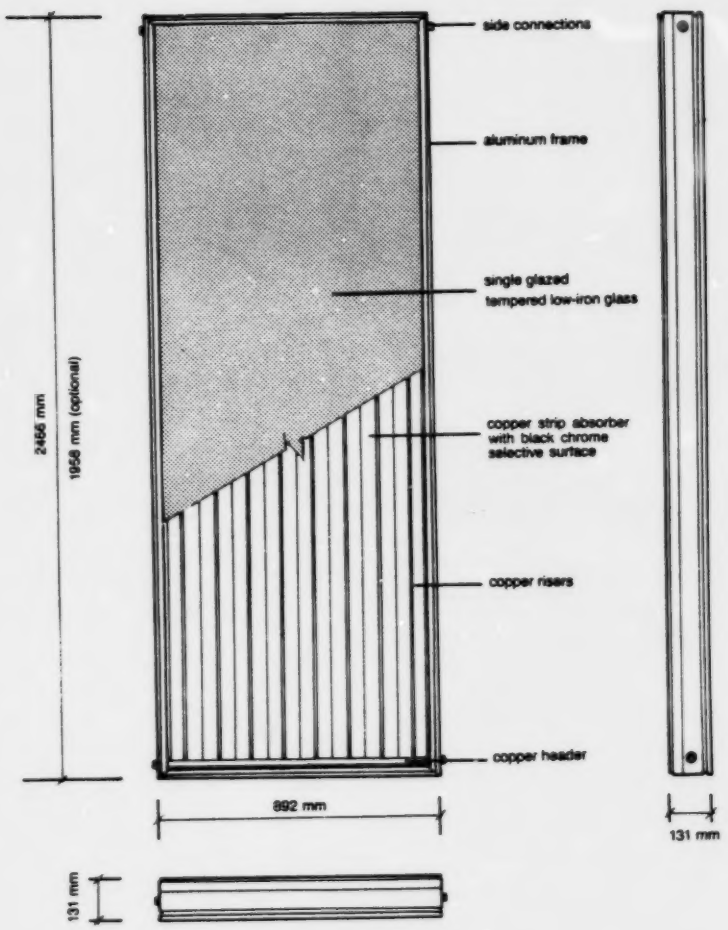
Pump: No maintenance.

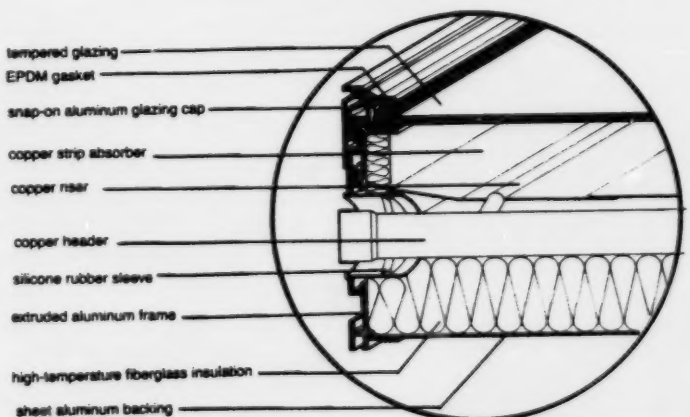
Solarsystems Industries Ltd.
2-11771 Horseshoe Way
Richmond, British Columbia
V7A 4S5

Erich W. Hoffmann
(604) 271-2621

Solarsystems SOL 100

Liquid Flat Plate Collector





A. General Information

1. Product Description:
SOL 100 collectors are single glazed with low-iron glass. Absorber is copper sheet formed over and continuously soldered to copper riser tubes. Surface is selective black chrome. Back and edge insulation is high-temperature fibreglass. Frame is extruded aluminum and the back is aluminum sheet.

1.1 Options:
Double glazing, black painted aluminum absorber, painted frame, end or bottom piping connections, prefabricated flashing, mounting racks.

1.2 Dimensions:
Standard: 892 mm × 2466 mm
Gross area: 2.200 m²
Net aperture area: 2.02 m²
Depth: 131 mm.

Optional: 892 mm × 1958 mm
Gross area: 1.750 m²
Net aperture area: 1.59 m²
Depth: 131 mm.

1.3 Weight:
Net weight: 48 kg (optional: 36 kg)
Shipping weight: 57 kg (optional: 43 kg)

2. Product Use:

2.1 Product Applications:
Domestic hot water and space heating.

2.2 Geographic and Climatic Limitations:
All cold climate regions.

3. Manufacturer's Experience:

3.1 Background:
Solarsystems Industries Ltd. was founded in 1976 and specializes in the design, manufacture, and installation of solar heating equipment.

3.2 Production:
300 m²; Sol 100 is a new model.

3.3 Projects:
11 domestic water heating systems in British Columbia using Sol 100 collectors; over 100 installations using earlier Model C-2 collectors.

Surrey Taxation Centre: 177 m² to be completed in late fall, 1980

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C. Absorber System

1. General Description:
Absorber consists of copper strips, formed to wrap partially around eight copper risers and continuously soldered with high-temperature solder. Risers are brazed to headers, which can have internal manifolding or which can be sloped internally for drain-back systems.

1.1 Generic Names:
Absorber: copper
Risers: type M copper
Surface: Harshaw selective black chrome on nickel substrate

1.2 Chemical Composition:
Absorber: 99.5% pure copper
Surface: proprietary information

1.3 Physical Treatment:
Standarad chemical treatment before electroplating

1.4 Dimensions:
Tube Diameter: 7 mm
Tube spacing: 106 mm
Plate thickness: 0.254 mm
Coating thickness: no data available

2. Optical Performance:

2.1 Absorptivity of Solar Radiation:
95% ± 2% (data supplied by Berry Solar)

2.2 Emissivity of Infrared Radiation:
10% ± 2% (data supplied by Berry Solar)

3. Thermal Performance:

3.1 Thermal Transfer:
Copper risers are 7 mm inside diameter, spaced 106 mm apart, and are continuously soldered to absorber.
Headers are 19 mm, or optionally 25 mm.

3.2 Coefficient of Thermal Expansion:
$16.8 \times 10^{-6} °C^{-1}$
Absorber floats within frame on its EPDM rubber gasket to accommodate thermal movement.

3.3 Thermal Capacity:
Weight of absorber: 9.85 kg
Specific heat: 0.38 kJ kg°C

3.4 Maximum Use Temperature:
Solder: 230°C
Brazing: 400°C
Chrome: 230°C

3.5 Minimum Use Temperature:
Below −40°C

4. Mechanical Integrity:
Panels have been stagnated by manufacturer for 30 days and then pressure-tested to 1000 kPa without apparent damage or failure.

5. Durability:

5.1 Chemical Resistance:
Suitable for use with neutral pH water, antifreeze, or non-organic heat transfer fluids compatible with copper.

5.2 Ultraviolet Degradation:
No ultraviolet degradation in anticipated.

5.3 Thermal Degradation:
All materials can withstand stagnation temperatures.

5.4 Moisture Damage:
Moisture does not affect the absorber or the selective surface. Moisture is able to drain from the collector through weep holes in the container.

Three-Collector Array on Wooden Mounting Rack

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E. Collector Assembly

1. General Description:
Collector consists of an aluminum frame and back plate, insulation, absorber plate, and the glazing.

1.1 Glazing Assembly:
Tempered glass is fitted with an extruded EPDM gasket which is held in place with a snap-on cap.

1.2 Absorber Assembly:
Copper tubes are soldered continuously to copper sheet. Absorber surface is coated with selective black chrome.

1.3 Insulation:
Side and back insulation is held in place by the absorber plate.

1.4 Collector Container:
Sides are extruded aluminum and the back is sheet aluminum riveted to the sides.

2. Collector Container:
Sides are 1.6 mm thick extruded aluminum, and corners are reinforced with internal aluminum corner brackets. Bottom is 0.51 mm aluminum sheet fitted in a groove and riveted.
place by a removeable internal extrusion and an outside snap-on cap.
The internal extrusion can be turned over to allow for single or double glazing.

2.1 Materials:
Extrusion: Alloy 663T5.
Back plate: utility grade aluminum

2.2 Finish:
Mill finish. Brown baked enamel top cap is available as an option.

2.3 Durability:
Expected service life is over 25 years.

3. Moisture Control:
Ventilating holes are located at the upper sides and weep holes at the bottom. Air is filtered through the fibreglass insulation to keep out dust.

4. Sealants and Gaskets:
Glass is sealed by a U-shaped EPDM gasket. The absorber plate is held in place by the header pipes which are secured by silicone rubber sleeves to the frame.

4.1 Trade Names:
EPDM rubber
Silicone rubber

4.2 Chemical Composition:
No data available

4.3 Physical Properties:
No data available

4.4 Thermal Performance:
Maximum continuous operating temperature is 120°C

4.5 Durability:
Anticipated life span is over 25 years.

F. Installation

1. Handling and Transportation:

1.1 Packaging:
Collectors are packed one to a cardboard box.

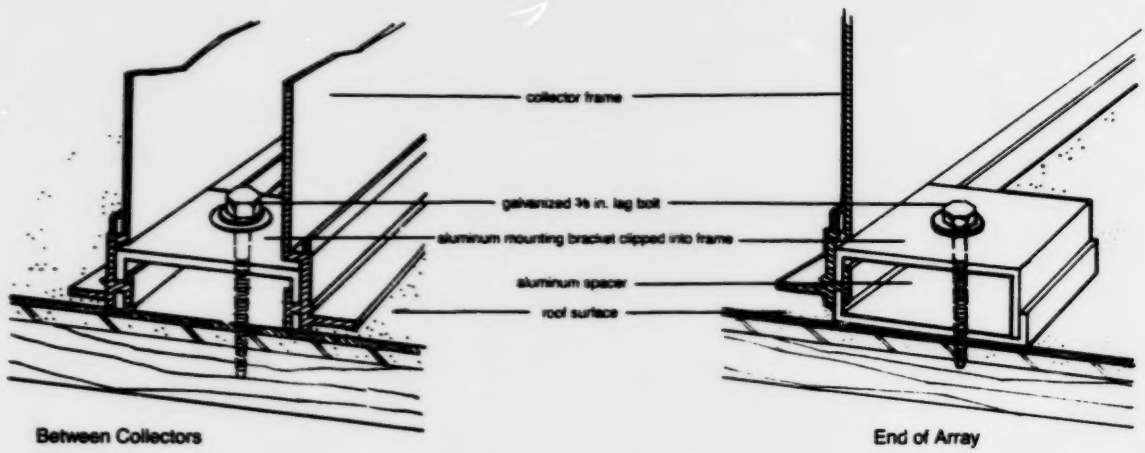
1.2 Labour and Equipment:
Two people are required to lift and install each collector.

2. Connection with Building Structure:
Aluminum brackets in a groove around the perimeter of the frame through-bolt to the structure. Aluminum spacers are used to elevate collectors above the supporting surface.
An optional mounting rack is available: contact factory for information.

3. Connection with Mechanical System:
Headers extend beyond the frame and are expanded to receive standard 19 mm (0.75 in) piping. With internal header model up to five panels can be connected in series. With drain-back model, an external header is used to connect panels. Panels with back connections are available on special order.

4. Start-Up Tests:
Pressure test with water to 670 kPa (100 psi). After start-up, check that temperature rise through all panels is equal to confirm equal flow distribution.

Surface Mounting Details



Between Collectors

End of Array

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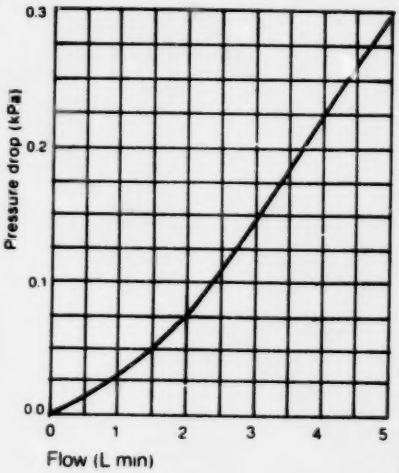
G. Operation

1. **General Method of Operation and Control:**
Collectors can be used with antifreeze systems or with drain-back systems using internally sloped headers.

2. **Pressure Drop vs. Collector Flow:**



2.1 **Testing Agency:**
Manufacturer's own tests

3. **Recommended Flow Rate:**
2.3 L/min

4. **Maximum Safe Operating Pressure:**
Factory-tested to 1000 kPa (150 psi)

5. **Recommended Operating Pressure:**
670 kPa (100 psi) maximum

6. **Maximum Safe Operating Temperature:**
Dry: 210°C (410°F)
Filled: 170°C (340°F)

7. **Stagnation Temperature:**
Single glazed: 200°C (392°F)

8. **Recommended Heat Transfer Medium:**
Water or any antifreeze or heat transfer liquid compatible with copper and with a neutral pH.

H. Maintenance

1. **Cleaning and Routine Maintenance:**
Collector glazing should be washed as necessary with standard widow washing materials;
Antifreeze solution should be checked annually and replaced as necessary.

2. **Manufacturer Servicing and Repair:**
Repair service is available upon request, although most repairs can be done by skilled trades people or the owner.

3. **Availability of Parts and Components:**
All components are available from the manufacturer or distributors.

4. **Replacement of Parts:**
Glazing is removed by first taking off flashing, if used, and then snapping off top cap. An individual collector can be removed from an array by cutting off connecting piping and removing hold-down bolts.

I. Durability

1. **Operating Experience:**

1.1 **Location:**
Richmond, B.C.

1.2 **Time Span:**
6 months; the Sol 100 collector is a new model

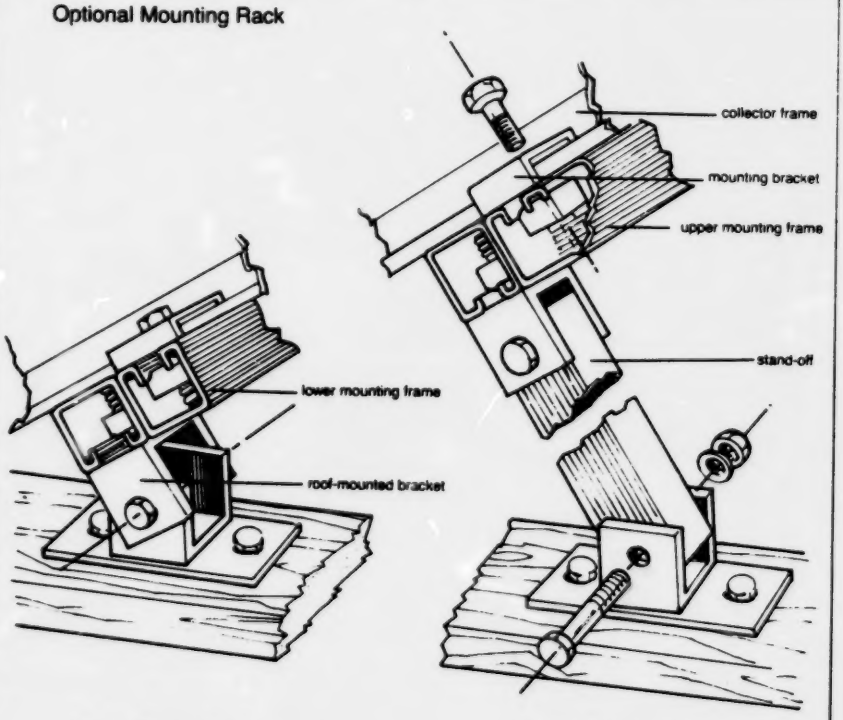
1.3 **Repairs:**
None

1.4 **Modifications:**
Method of applying side insulation has been changed.

1.5 **Independent Assessment:**
Mr. Mitchell
11980 Flamingo Court
Richmond, B.C.

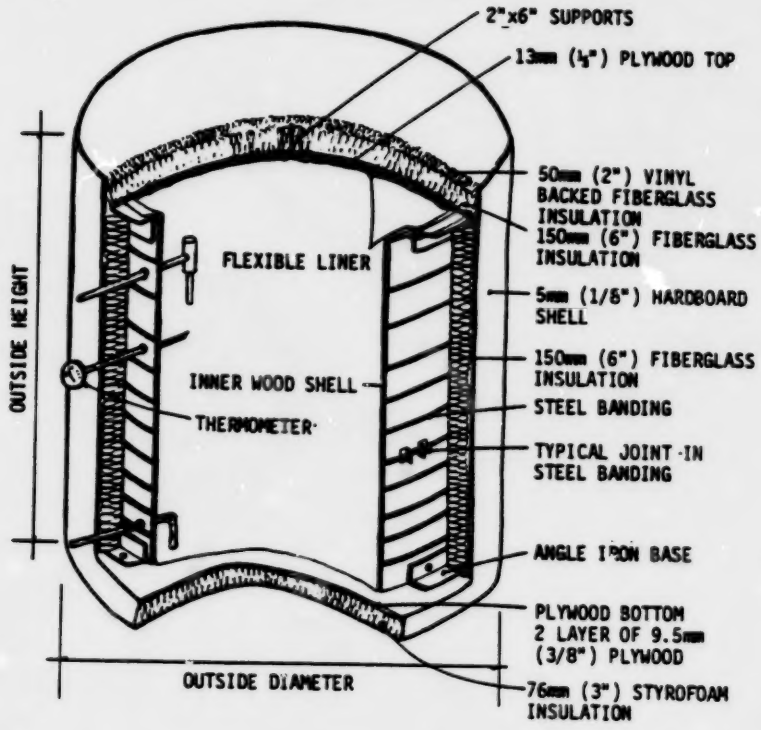
2. **Accelerated Aging Tests:**
No tests have been carried out.

Optional Mounting Rack



Lower Frame Detail

Upper Frame Detail



Now available for the first time, site fabricated solar storage tanks for commercial installations.

Large solar storage tanks have created a problem for solar designers. Large steel tanks are heavy, expensive, and corrosion can be a problem. With conventional tanks it may be necessary to remove and rebuild walls if tank access is not available.

The Solarsystems SOL 750 storage tanks eliminates these problems.

1. Tanks are available in kit form. All components can be carried through any standard man door. There is no need to knock out walls for access.

2. Tanks come in a full range of sizes. Tanks can easily be supplied to design specifications. The solar designer can specify tank dimensions to make maximum use of valuable space.

3. Tanks are extremely well insulated to minimize heat losses. A large single tank is superior to multiple small tanks due to better insulation and less exposed surface area per unit volume.

4. Attractive hardboard outer shell can be painted to match existing walls.

5. Tanks can be specified with an unlimited combination of bulkhead fittings, heat exchangers or thermometer wells for design flexibility.

6. Tanks are very light weight and knocked down shipping reduces transportation costs.

7. Non-corroding vinyl or PVC liners assure a design life of 25 years even with the most corrosive water.

8. Detailed installation instructions are provided with each tank for quick, simple construction.

Tank Construction

The tank is of composite construction making use of the best properties of materials.
A wooden tank shell, reinforced top and bottom with angle iron rings provides stiffness. Circular glavanized steel banding provides hoop strength and a flexible plastic liner provides watertightness.
Fiberglass insulation retains the heat and is protected by a hardboard shell.
A small quantity of motor oil on top of the water surface will help to retard evaporation. The overflow fitting has been designed to prevent loss of oil in case of overfilling.

Heat Loss

To conserve the solar energy collected, the tanks are extremely well insulated.
Typical performance data are as follows:

Average tank temperature	70°C (158°F)
Room temperature	20°C (68°F)

Tank on concrete slab
Theoretical heat loss of 9600 liter tank
435 Watt (1485 BTU/hr)
Theoretical temperature drop in 24 hours
1°C (1.8°F)

Temperature Limitations

The tanks are available with two different liners. Flexible PVC liner is suitable for continuous operation at 80°C (176°F) and intermittent operation at 100°C (212°F).
Vinyl liner is for 70°C (150°F) continuous temperature which should never be exceeded.

Bulkhead Fittings

To allow connection of piping to the tanks, bulkhead fittings will be supplied and the tank predrilled to customers drawings. The fittings have screw connections for external piping. The following sizes are available: 1/2, 3/4, 1, 1 1/2, and 2 inches.

Erection Method

The tank can be erected by three men, using ordinary installation tools. The tank liner is completely prefabricated for tanks up to 3m (10 ft.) outside diameter. For larger tanks the liner is shipped prefabricated and is finish welded by SOLARSYSTEMS personnel on site.

Tools Required

Standard plumbing and carpenters tools only are required. The only special tool is a hand riveter suitable for 2.9mm (0.114 inch) mandrel, which can be hand or pneumatic actuated.

Packaging and Shipment

The tanks are shipped knocked down.
Maximum package size 4 x 8 x 1 ft.

TANK SPECIFICATIONS

WALL:
Aspenite panels (hardboard for small tanks) bent to the required radius. Joints are overlapped and riveted with 3/16" aluminum rivets.
Galvanized steel reinforcing bands 19x0.89mm (3/4x 0.035") spaced proportional to the water pressure. Predrilled bolted connectors supplied. Design safety factor 4.

FLOOR:
Two layers of 9.5mm (3/8") plywood at right angles, screwed together. Circular reinforcing ring of 50x50x3 (2x2x1/8") angle iron screwed to floor.

LID:
Plywood 13mm (1/2") supported by 2x6 framing. Circular reinforcing ring of 50x50x3 (2x2x1/8") angle iron screwed to wall.

LINER:
Welded flexible PVC liner 1.2mm (0.047") thick. Maximum continuous temperature 80°C (176°F). Max-

1mm short time temperature 100°C (212°F).
Optional liner all welded vinyl, 0.76mm (0.030") thick. Maximum continuous temperature 70°C (158°F) Use of this liner requires overtemperature protection.

INSULATION:
Floor 76mm (3") styrofoam
Walls two layers of 76mm (3") or a total of 152mm (6") paper backed fiberglass.
Lid 152mm (6") friction fit fiberglass covered with 55mm (2") vinyl backed fiberglass. All joints are taped with vinyl tape.

OUTSIDE FINISH:
Hardboard panels bent to the required radius. Joints are overlapped and riveted.

PIPE FITTINGS:
Tank walls are predrilled for bulkhead fittings. Tank liner to be cut to suit. Bulkhead fittings are complete with gaskets ready to be screwed to tank wall.
Bottom drain fitting with 1/2" dry well reaching well into the tank for differential controller fitting.
Thermometer fitting with 1/2 FIP thread for thermometer and plastic tube for tank level indication.
Top overflow fitting with internal tee to allow tank to be fully filled and to prevent loss of oil on overflow.

DESIGN LIMITS:
Tank is designed as a non pressurized container for water. The overflow must always be open to the atmosphere.
The steel banding is designed with a safety factor of 4.
The tank must be placed on a level floor capable of safely supporting the weight. Tank to be located so not to be exposed to impact or mechanical damage.

ENGINEERS SPECIFICATIONS

The solar storage tank shall be of composite construction, prefabricated for assembly in the field. All components shall be small enough to fit through a standard mm door.

The shell shall be of 6.3mm (1/4") wood panels, reinforced with steel banding, designed for a safety factor of 4. The shell shall be fastened top and bottom to rings formed from 50x50x3.1mm (2"x2"x1/8") angle iron which in turn shall be fastened to the plywood cover and floor.

The liner shall be flexible PVC, thickness 1.2mm, heat welded, double overlapped welds. (Optional: The liner shall be vinyl, thickness 0.76mm, high frequency welded).

Brass bulkhead fittings with neoprene washers shall be used for pipe connections.

Insulation shall be 76mm styrofoam under the tanks, 152mm fiberglass on the walls, and 200mm on the cover.

The circumference of the tank shall be finished off with hardboard suitably curved. The top insulation shall have integral vinyl cover, suitably taped with vinyl tape for a neat finish.

The tank shall be _____mm diameter, _____mm high over the insulation, volume _____liter. Design heat loss shall not exceed _____ W/°C at 70°C water temperature and 20°C room temperature.
Bulkhead fittings and heat exchangers shall be as shown on the drawings.
The tank shall be Solarsystems Industries Ltd. SOL 750 Item No. _____ or approved equal.

SOL 750 TANK CAPACITY AND DIMENSIONS

CATALOGUE NUMBER		METRIC MEASUREMENTS						IMPERIAL MEASUREMENTS					
PVC Liner	Vinyl Liner	OUTSIDE DIAMETER mm	OUTSIDE HEIGHT mm	VOLUME l	HEAT LOSS W/°C	SHIPPING WEIGHT kg	WATER WEIGHT kg	OUTSIDE DIAMETER in.	OUTSIDE HEIGHT in.	VOLUME US gal	HEAT LOSS BTU/hr	SHIPPING WEIGHT pounds	WATER WEIGHT pounds
30-311	30-361	1 524	2 030	1 810	3.5	225	1 810	60	80	480	20	500	4,020
-312	-362	1 524	2 440	2 240	4.1	260	2 240	60	96	590	23	570	4,940
-313	-363	1 830	2 030	2 870	4.5	310	2 870	72	80	760	26	680	6,360
-314	-364	1 830	2 440	3 570	5.2	340	3 570	72	96	940	29	750	7,870
-315	-365	2 440	2 030	5 740	6.7	425	5 740	96	80	1,520	38	940	12,720
-316	-366	2 440	2 440	7 130	7.6	480	7 130	96	96	1,880	43	1050	15,740
-317	-367	2 440	2 700	8 020	8.2	510	8 020	96	106	2,120	46	1120	17,740
-318	-368	3 050	2 030	9 600	9.3	625	9 600	120	80	2,540	53	1380	21,260
-319	-369	3 050	2 440	11 900	10.4	670	11 900	120	96	3,150	59	1480	26,370
-320	-370	3 050	3 050	15 350	12.0	710	15 350	120	106	4,060	68	1560	33,980
-321	-371	3 050	3 250	16 540	12.6	800	16 540	120	128	4,370	72	1750	36,580
-322	-372	3 660	2 438	17 910	13.5	890	17 910	144	96	4,730	77	2000	39,590
-323	-373	3 660	2 700	20 170	14.4	940	20 170	144	106	5,330	82	2100	44,600
-324	-374	3 660	3 250	24 870	16.2	1040	24 870	144	128	6,570	92	2300	55,000
-325	-375	4 270	2 440	25 140	17.1	1130	25 140	168	96	6,640	97	2500	55,600
-326	-376	4 270	2 700	28 300	18.1	1180	28 300	168	106	7,480	103	2600	62,600
-327	-327	4 270	3 250	34 900	20.1	1300	34 900	168	128	9,230	114	2900	77,300

Tanks are avialable in custom sizes, minimum diameter 1524 mm (60 in.), maximum height 3 250 mm (128 in.)

SOLARSYSTEMS
SPECIFICATIONS
GUIDE

DIFFERENTIAL THERMOSTATS

Solarsystems Industries Ltd.
#2 - 11771 Horseshoe Way
Richmond, B.C. Canada V7A 4S5
(604) 271-2621

TECHNICAL SPECIFICATION

Type: Differential

Dimensions: 6.4 x 10 x 19 cm

Application: Controls flow of water or air through collectors

Power Input: 120 volts, 10 watts

Switching Capacity: Up to 10 amps

Operation: Electronic circuitry with mechanical relay and triac

Standard Differentials Available:
5-15°C on, 0-4°C off

User Adjustable: Yes, screwdriver adjustment (internal)
dial adjustment (external) on pool controls

Sensors Supplied: No

Sensitivity: 0.5° C

Operating Range: Maximum sensor temperature 150° C

PRODUCT DESCRIPTION

Electronic differential thermostats with remote sensors; sixteen different models for domestic hot water and space heating or for pools.

Features: On and off differentials separately adjustable and adjustment for high limit option.

Options: Special ranges and output relays available. Freeze Protection or High Temperature limit.

Installation Requirements: Dry locations only.

Maintenance Requirements: None

Guarantee/Warranty: 1 yr.

Approvals: C.S.A. Approved

DIFFERENTIAL THERMOSTAT FOR SOLAR HEATING
OPERATING AND INSTALLATION INSTRUCTIONS

1. DESCRIPTION - The Solarsystems differential thermostat is the device which automatically operates the solar heating system.

   Two sensors are wired to the controller to detect temperature. One senses the solar collector temperature, the other senses the reference temperature; a tank or pool water temperature. Whenever the solar collector temperature exceeds the reference temperature the system is energized. Whenever the collector temperature drops below the reference temperature, the system is de-energized.

   In case of a domestic water or space heating system, a pump is energized to move water through the collector. In case of a pool heating system, electric valves change position to cause flow of water to the collectors. The system may cycle ON - OFF several times in the morning and in the evening or on overcast days, when there is not sufficient sunshine to maintain circulation.

2. MODES OF OPERATION - The manual switch on the thermostat has 3 positions: ON, OFF, AUTO. The control should be left in the AUTO position for normal operation.

   ON POSITION: The system is energized continuously, whether the sun is shining or not. This position is used for testing only.
   OFF POSITION: The system is shut down.
   AUTO POSITION: The system will cycle on and off automatically, collecting heat whenever the sun is shining.

3. INDICATING LIGHT - A small red light on the front of the thermostat is labelled "Solar On". This light is on whenever the temperature at the solar panels is higher than the reference temperature; in other words when the sun is shining and solar heat is available. If the light is on, water should circulate through the collectors.

4. INSTALLATION

Mount the differential thermostat on a vertical surface in a dry location near an available 120 volt receptacle or outlet box.

The tank sensor must be in good thermal contact with the tank water. Push sensor into a dry-well near the bottom of the tank or strap to the tank wall or to the pump suction pipe as close to the tank as possible. For pool heating, mount sensor with the compression fitting provided in the strainer bowl of the pump.

The collector sensor must be strapped to the outlet pipe of the collector as near to the collector as possible, or pushed into the elbow with a dry-well provided with the collectors.

Any sensors strapped to the outside of pipes must be well insulated. Wiring from the sensors must be extended to the differential thermostat by means of 2 #18 LV wire (low voltage thermostat wire). All wire connections must be soldered using the solder supplied (rosin core solder). Do not use acid core solder or plumbers soldering paste, it will cause the wires to corrode.

DIFFERENTIAL THERMOSTATS

DOMESTIC WATER AND SPACE HEATING

		PLUG, CORD & RECEPTACLE				HARD-WIRED			
MODEL DT-		11 P	12 P	14 P	16 P	11 H	12 H	14 H	16 H
CATALOGUE NO.		50-011	50-012	50-014	50-016	50-021	50-022	50-024	50-026
DHW/SPACE HEATING		*	*	*	*	*	*	*	*
OVER-TEMP (70-90°C)	Pump runs until tank cools		*				*		
	Pump stops when tank over temp.			*				*	
FREEZE PROTECTION (extra output 24V AC)					*				*

OUTPUT RATING : 120V AC, 10A, ½ HP

FREEZE PROTECTION OUTPUT: 24V AC, 12.5 VA

POOL AND SPA HEATING

	PLUG & CORD			HARD-WIRED				
MODEL DT-	31 P	32 P	35 P	31 H	32 H	36 H	39 H	40 H
CATALOGUE NO.	50-031	50-032	50-035	50-041	50-042	50-046	50-049	50-050
POOL/SPA HEATING	*	*	*	*	*	*	*	*
HIGH TEMP (20-45°C)		*	*		*	*	*	*
REMOTE TRANSFORMER (240V AC)						*	*	
12 VAC OUTPUT (FOR 3-WAY VALVE)			*				*	*

OUTPUT RATED 24V AC, 0.5A. Models DT-35P, -39H, and 40H have S.P.D.T. relay outputs for 3-way valves R224 (50-139)

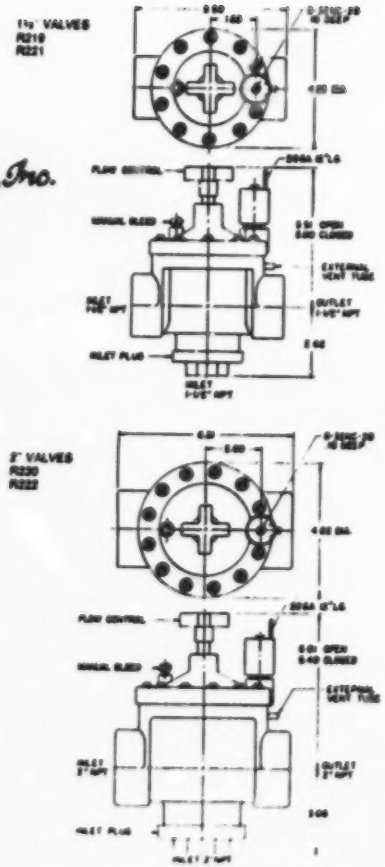
NOTES:

1. Order sensors separately

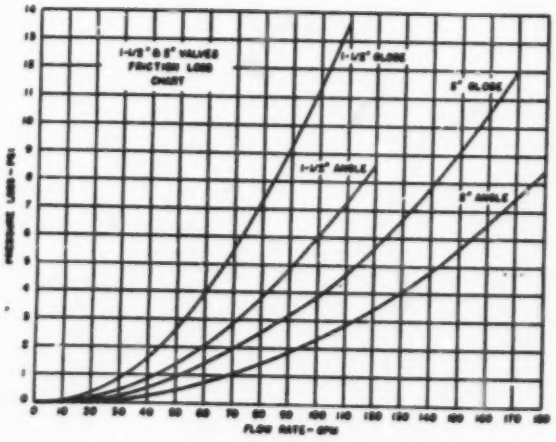
   50-090 Collector sensor mounting pack (pool)
   50-091 Sensor; rubber encased or short copper sheath
   50-092 Sensor with screw fitting ½" N.P.T.
   50-093 Sensor with inverted screw fitting ½" N.P.T.
   50-094 Sensor; long copper sheath

2. Models DT-36H and -39H have transformers (24V AC to 24V AC) supplied.

RICHDEL Inc.
SOLAR PRODUCTS



HYDRAULIC CHARACTERISTICS



ELECTRICAL CHARACTERISTICS

Solenoid construction: Heavy duty, weatherproof epoxy encapsulated coil. Standard 12VAC or 24VAC, 60 Hz. Other voltages, D.C. and conduit adaptor available

Volt amp rating: Inrush 11.6 VA
Holding 5.75 VA

START UP

Refer to the collector manufacturer's instructions for start up since different collectors require different precautions. Failure to do so may result in collector or system damage.

In general, the valve flow control adjustment shaft should be rotated counter-clockwise to open the valve fully. Flow should be directed through the valve for 10 to 15 minutes. This should remove any air entrapped in the valve.

After this, turn flow control knob to your desired volume.

The normally closed valve when coil is de-energized (valve closed) may be opened manually at the valve by loosening the manual bleed screw.

The normally open valve when coil is energized (valve closed) may be manually opened at the valve by loosening the manual bleed screw. The valve should close within several minutes after retightening this screw. Water flow is normal thru vent tube anytime a valve is open.

MAINTENANCE

Avoid inserting pool chemicals near the pump intake or the skimmer, since this will cause a distribution of concentrated corrosive chemicals through the pump, filter, collector and valves.

Your valve should not require maintenance unless a failure of the filter system has previously occurred, in which case debris may have collected in the valve bleed passages or concentrated chemicals have caused corrosion of the solenoid mechanism. The solenoid may be unscrewed from its socket and the socket can then be inspected for the general condition regarding corrosion and contamination.

Periodically inspect suction line tubing and connections at the valve and pump and for possible leakage.

SERVICE

Richdel valves are serviceable without removal from system. Servicing should be done by experienced personnel, however customer servicing may be performed by following the "Valve Trouble Shooting Guide" available at Richdel Solar Dealerships.

For Warranty Service, refer to accompanying warranty.

GENERAL DESCRIPTION

These valve models are described as solenoid pilot operated diaphragm valves, either normally closed or normally open, with a hydraulic assist for full valve opening by connecting the top side of the diaphragm to pump suction thru the vent tube provided on the side of valve.

In solar heating systems for pools these valves are used to divert flow from the normal filter loop to the solar collectors. This is accomplished automatically by a command from a differential temperature controller.

MONARCH INDUSTRIES LIMITED

GENERAL PURPOSE CENTRIFUGAL PUMPS

AC SERIES — END SUCTION CENTRIFUGAL PUMPS — ENCLOSED IMPELLER — WITH MECHANICAL SEAL

ACT SERIES — TRANSMISSION DRIVE — STANDARD FITTED CONSTRUCTION*

MODEL No.	ORDERING No.	SHIP. WT.	SUCTION & DISCHARGE	CAPACITIES US GPH 1750 RPM	CAPACITIES US GPH 3450 RPM	TRANSMISSION DATA
ACT-4	614990	16	1¼"x1"	1250	3600	Shaft size ⅝". Keyway ⅛".
ACT-5	615000	16	1½"x1¼"	1550	3600	Mechanical Seal. Shaft Assy.
ACT-6	615010	20	2 "x1½"	2200	3650	with Sealed Ball Bearings.

*ACT-5 and ACT-6 have bronze impellers!

ACT

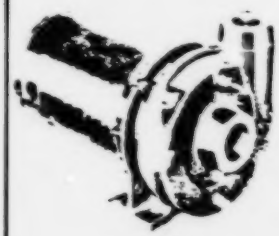
PERFORMANCE CHART FOR ACT SERIES

PUMP MODEL No.	PUMP SIZE SUCT.	PUMP SIZE DISCH.	RPM	HP	TOTAL HEAD INCLUDING FRICTION IN FEET: 15	20	30	40	50	60	80	100	120
					CAPACITIES IN US GPM BASED ON 10 FT. TSL								
ACT-4	1¼"	1"	1750	¼	21	11							
			2400	½		37	27	9					
			2850	¾		50	43	25	23				
			3450	1			60	54	48	40	17		
ACT-5	1½"	1¼"	1750	¼	26	18							
			2400	¾		44	35	22					
			2850	1			50	44	34	19			
			3450	1½			60	59	57	52	35		
ACT-6	2"	1½"	1750	⅓	37	31	11						
			2400	1		54	48	41	29	6			
			2850	1½			58	57	53	45	20		
			3450	3			64	63	62	61	59	46	20

ACE SERIES — ELECTRIC DRIVE — STANDARD FITTED CONSTRUCTION*

MODEL No.	ORDERING No.	SHIP. WT.	SUCTION & DISCHARGE	CAPACITIES US GPH	HP	MOTOR CHARACTERISTICS
ACE-33	615020	35	1¼"x1"	2900	⅓	Stainless Steel Motor Shaft.
ACE-50	615030	37	1¼"x1"	3400	½	115 V. 1 ph. — 3450 RPM.
ACE-75	615040	42	1½"x1¼"	3800	¾	Stainless Steel Motor Shaft
CE-100	615050	47	1½"x1¼"	3850	1	115/230 V. 1 ph — 3450
CE-150	615060	52	"x1½"	3900	1½	RPM. Also available with 230
ACE-200	615070	54	2 "x1½"	3950	2	or 575 V. 3 ph. when so specified. (Price on Application).

*ACE-100, ACE-150 and ACE-200 have bronze impellers!



ACE

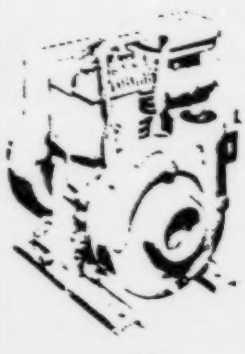
PERFORMANCE CHART FOR ACE SERIES

PUMP MODEL No	PUMP SIZE SUCT.	PUMP SIZE DISCH.	HP	TOTAL HEAD INCLUDING FRICTION IN FEET: 20	30	40	50	60	70	80	90	100	110	120
				CAPACITIES IN US GPM BASED ON 10 FT. TSL										
ACE-33	1¼"	1"	⅓	49	42	33	21	4						
ACE-50	1¼"	1"	½	57	51	44	35	24	8					
ACE-75	1½"	1¼"	¾	66	61	54	47	40	30	19				
ACE-100	1½"	1¼"	1			60	57	51	44	35	22			
ACE-150	2"	1½"	1½		62	62	61	60	55	48	38	27	11	
ACE-200	2"	1½"	2		63	63	63	62	62	61	55	47	36	22

ACG SERIES — GAS ENGINE DRIVE — BRONZE FITTED CONSTRUCTION

MODEL No.	ORDERING No.	SHIP. WT.	SUCTION & DISCHARGE	CAPACITIES US GPH UP TO	ENGINE DATA
ACG-4	615080	42	1¼"x1"	3100	Briggs & Stratton Model 60112
ACG-5	615090	43	1½"x1¼"	3500	2 HP with 1 qt. fuel tank and rewind starter.
ACG-6	615100	48	2 "x1½"	3950	Briggs & Stratton Model 80232 3 HP with 2 qt. fuel tank and rewind starter.

Above units have bronze impellers



ACG

PERFORMANCE CHART FOR ACG SERIES

PUMP MODEL No.	PUMP SIZE SUCT.	PUMP SIZE DISCH.	TOTAL HEAD INCLUDING FRICTION IN FEET: 40	60	80	90	100	110	120	130	140	150	160	170
			CAPACITIES IN US GPM BASED ON 5 FT. TSL											
ACG-4	1¼"	1"	52	51	44	38	30	22	12					
ACG-5	1½"	1¼"	59	56	47	41	34	26	16					
ACG-6	2"	1½"	66	64	61	57	52	47	42	35	29	22	15	7

INTERCHANGEABLE
CURVE-MATCHED
THERMISTOR

UNI-CURVE

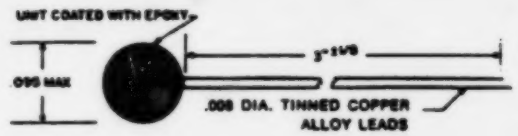
COLOR CODE: RED

UUA 41J1 • 10,000 OHMS AT 25°C • ±0.2°C • 0–70°C

Temp. °C	Resist.	Temp. °C	Resist.	Temp. °C	Resist.
−80	7,368,000	− 3	38,110	74	1,530.0
−79	6,740,300	− 2	36,190	75	1,479.0
−78	6,170,300	− 1	34,370	76	1,431.0
−77	5,652,600	0	32,650	77	1,384.0
−76	5,181,600	1	31,030	78	1,340.0
−75	4,753,000	2	29,500	79	1,297.0
−74	4,363,000	3	28,050	80	1,255.0
−73	4,007,300	4	26,690	81	1,215.0
−72	3,683,300	5	25,390	82	1,177.0
−71	3,387,700	6	24,170	83	1,140.0
−70	3,117,500	7	23,010	84	1,104.0
−69	2,870,800	8	21,920	85	1,070.0
−68	2,645,300	9	20,880	86	1,036.0
−67	2,439,000	10	19,900	87	1,004.0
−66	2,250,200	11	18,970	88	973.70
−65	2,077,200	12	18,090	89	944.00
−64	1,918,700	13	17,250	90	915.30
−63	1,773,300	14	16,460	91	887.70
−62	1,639,900	15	15,710	92	861.00
−61	1,517,400	16	15,000	93	835.30
−60	1,404,900	17	14,320	94	810.30
−59	1,301,400	18	13,680	95	786.70
−58	1,206,300	19	13,070	96	763.30
−57	1,118,700	20	12,490	97	741.00
−56	1,038,000	21	11,940	98	719.30
−55	963,700	22	11,420	99	698.70
−54	895,200	23	10,920	100	678.30
−53	832,000	24	10,450	101	659.00
−52	773,700	25	10,000	102	640.30
−51	719,900	26	9,573.0	103	622.00
−50	670,100	27	9,167.0	104	604.30
−49	624,100	28	8,777.0	105	587.30
−48	581,500	29	8,407.0	106	571.00
−47	542,200	30	8,057.0	107	555.00
−46	505,700	31	7,723.0	108	539.70
−45	471,900	32	7,403.0	109	525.00
−44	440,600	33	7,097.0	110	510.30
−43	411,600	34	6,807.0	111	496.70
−42	384,700	35	6,530.0	112	483.00
−41	359,700	36	6,267.0	113	470.00
−40	336,500	37	6,017.0	114	457.30
−39	314,900	38	5,777.0	115	445.00
−38	294,800	39	5,547.0	116	433.30
−37	276,200	40	5,327.0	117	421.70
−36	258,800	41	5,117.0	118	410.70
−35	242,700	42	4,917.0	119	400.00
−34	227,600	43	4,727.0	120	389.30
−33	213,600	44	4,543.0	121	379.30
−32	200,500	45	4,370.0	122	369.70
−31	188,300	46	4,200.0	123	360.00
−30	177,000	47	4,040.0	124	350.60
−29	166,300	48	3,890.0	125	341.70
−28	156,400	49	3,743.0	126	333.10
−27	147,200	50	3,603.0	127	324.70
−26	138,500	51	3,467.0	128	316.50
−25	130,400	52	3,340.0	129	308.60
−24	122,800	53	3,217.0	130	300.93
−23	115,700	54	3,099.0	131	293.47
−22	109,100	55	2,986.0	132	286.23
−21	102,900	56	2,878.0	133	279.17
−20	97,070	57	2,774.0	134	272.03
−19	91,610	58	2,675.0	135	265.70
−18	86,490	59	2,579.0	136	259.30
−17	81,690	60	2,488.0	137	253.00
−16	77,180	61	2,400.0	138	246.93
−15	72,950	62	2,316.0	139	241.03
−14	68,980	63	2,235.0	140	235.27
−13	65,240	64	2,157.0	141	229.70
−12	61,730	65	2,083.0	142	224.30
−11	58,430	66	2,011.0	143	219.00
−10	55,330	67	1,942.0	144	213.90
− 9	52,400	68	1,876.0	145	208.87
− 8	49,650	69	1,813.0	146	204.03
− 7	47,060	70	1,752.0	147	199.33
− 6	44,620	71	1,693.0	148	194.77
− 5	42,330	72	1,636.0	149	190.33
− 4	40,160	73	1,582.0	150	185.97

UUA 41J8 • 10,000 OHMS AT 25°C • ±0.2°C • 0–100°C

UUT SERIES



UNI-CURVE INTERCHANGEABLE THERMISTOR:

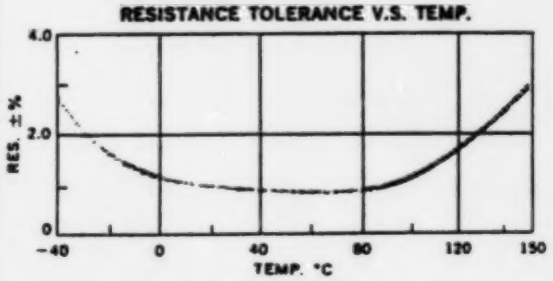
Epoxy encapsulated, precision matched to standardized resistance temperature curve, providing predicted temperature accuracy based on resistance values and tolerance over the entire temperature range.

Condition	Dissipation Constant*	Time Constant**
Still Air	1mw/°C	10 sec. max.
Stirred Oil Bath	8 mw/°C	1 sec. max.

*D.C. — Power in milliwatts required to raise thermistor temperature 1°C.

**T.C. — Time required for thermistor to indicate 63% of a new impressed temperature

RESISTANCE TOLERANCE V.S. TEMP.



TEMPERATURE TOLERANCE